

technical requirements, are sufficient to guide even a beginner, and this is attained, among other means, by the inclusion of the whole account in a single paragraph, in place of the old plan of subjoining to an often curt diagnosis, sometimes barely intelligible without special study of the family or genus, a more or less loosely constructed note, usually in small print, on sundry features of the species, which might or might not, as things fall out, fulfil the end of a detailed description.

Another commendable feature of the work is presented in the analytical keys that are prefixed to the larger or more difficult genera. There is nothing easier, in a way, for a systematic writer than to make such a key on paper, and the more easily it has been made the more likely is it to be found in practice unworkable, or worse than useless; but the keys in this instance have been manifestly framed with some regard to the natural groupings of the species, and are clearly the result of personal and accurate examination of the material. As illustrations we may mention the synopsis at pp. 98-9 of the Bombay species of *Diospyros*, of *Cordia* (p. 199), *Strobilanthes* (pp. 365-6), and of the often almost hopeless genera of grasses (in the stricter sense). For the last-named very important family—the despair almost of taxonomists—Dr. Cooke has followed rather closely the arrangement made by Dr. Otto Stapf in the “*Flora Capensis*,” which is that most generally now adopted, and, whatever may be thought of this as a comprehensive scheme for this difficult family, it must be admitted that Dr. Cooke’s treatment of such genera as *Panicum* and *Eragrostis*, to say nothing of *Andropogon*, has been fitted to it in a very workmanlike and skilful manner, without sacrificing detailed observations of the actual structure of the species, that are palpably the fruit of indefatigable work with the lens, by the author.

A like scrupulous accuracy pervades the nomenclature throughout the volume, though in some cases whole-hearted disciples of the Vienna Congress will miss sundry emendations that have doubtless been avoided purposely, for reasons analogous to those that have dictated, in the preparation of these Indian and colonial floras, adherence to the “*Genera Plantarum*” of Bentham and Hooker, as against the more recent work of Engler and Prantl. In the case of compendia founded, as the present is expressly, on the “*Flora of British India*,” this is practically unavoidable, but in the analysis of families, and in some minuter matters, Dr. Cooke has shown, if anything, a shade too much deference to those monumental authorities. Take, for example, the arrangement of the tribes and subtribes in *Compositæ* (pp. 1-6). Assuming that *Astereæ* can be kept up as a tribe apart from *Inuleæ*, and that both should continue, even in a linear arrangement, to stand far apart from *Senecionideæ* through the intercalation of *Helianthideæ*, *Helenoideæ*, and *Anthemideæ*, surely it is time to revise the subtribes of *Astereæ*. No doubt the solitary representative of the genus *Erigeron* found in Dr. Cooke’s area, if it should be kept as an *Erigeron* at all, conforms to the defini-

tion of the subtribe “*Heterochromeæ*” by G. Bentham; but discoveries by the Abbé Delavay, by Wilson, and others in the Indo-Chinese region have shown that there are true *Asters*, and perhaps members of the allied genus *Erigeron*, that have the disk florets of the same bluish tint as the ligules, though of deeper intensity. In the “*Genera Plantarum*” it was admitted that in several genera all the florets are yellow, but now that the converse exception is known to affect the type-genus of the tribe, the division into *Heterochromeæ* and *Homochromeæ* seems to call for reconsideration.

A minor case suggests itself at pp. 1030-31, where the careful work of Jaubert and Spach on the actual forms of *Melanocenchris* has been swamped for the sake of resuscitating Koenig’s practically barren title for the genus (*Gracilea*). This, of course, is a debatable example, but the same can hardly be said for the citation of Linnæus at p. 479 for the genus *Boerhaavia*, which Linné himself was most careful to attribute to its real author, Vaillant. In restoring *B. diffusa*, Linn., to the rank of a variety, Sir Joseph Hooker had, in fact, given the clue, because one or other of the two forms put under *B. repens* in the “*Species Plantarum*” was the type of Vaillant’s genus. Whether either of those be identical with the *B. diffusa* of Linné can be decided only by inspection of the authentic types collected in Abyssinia by Lippi.

Dr. Cooke’s “*Flora*” was commenced in 1900, and the first part appeared in July, 1901. On May 1, 1902, the Bombay herbarium at the Poona College of Science was destroyed by fire, and he has since had to depend largely on his own collections and those of Woodrow to supplement the classical material at Kew. He has examined and described 2502 indigenous species, and dealt with more than 500 introduced or cultivated plants known to the Presidency, distributed among 1029 genera and 148 families, embracing types of widely divergent affinities, and belonging to such diverse phytogeographical regions as the Oriental, East African, and Indo-Malayan. It is no mean achievement in itself to have completed such a task successfully. The final part is accompanied by a carefully prepared index to the book as a whole, and this is in two parts, the vernacular names being indexed by themselves, which, for most purposes, is the most convenient arrangement.

#### THE TEACHING OF PHYSICAL CHEMISTRY.

- (1) *The Elements of Physical Chemistry*. By Prof. J. Livingston R. Morgan. Fourth edition, revised and enlarged. Pp. xiv+539. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1908.) Price 12s. 6d. net.
- (2) *Outlines of Physical Chemistry*. By Dr. George Senter. Pp. xvii+369. (London: Methuen and Co., n.d.) Price 3s. 6d.

(1) THE fact that the former of the above-mentioned text-books has, in the space of a single decade, passed into its fourth edition, is sufficient evidence that the work has met with a large share of approval, and has shown it to be adapted to the requirements

of a large number of students of physical chemistry. Within the limits which the author has allowed himself, a very large amount of experimental work has been collected and discussed, and in this connection even the most recent work has received attention. In the initial chapters, however, dealing with the physical properties of substances, the author has been somewhat niggardly, and one is struck by a want of balance. Thus, whereas twenty pages have been allotted to the discussion of surface tension and the molecular weight in the liquid state, together with an excellent account of the author's drop method, barely a page has been devoted to refraction of light, and no mention at all is made of the rotation of the plane of polarised light. It must be confessed, also, that at times the condensation of language makes the reading of the book somewhat of a strain, and is productive of want of lucidity; so that the book, in parts, assumes the character of lecture notes rather than that of a self-explanatory text-book. In many cases, however, the author has been successful in minimising this evil by the insertion of tables of experimental results, and by the working out of numerical examples. This last feature of the book is indeed one to be greatly commended. No one can obtain a useful grip of physical chemistry without the study and actual working out of numerical problems. The collection of such problems inserted at the end of the book will therefore be of great value, both to the teacher and to the student.

The author has not been afraid to employ the methods of the calculus or to introduce the student at an early point to the study of thermodynamics. We can only wish that such a method might be adopted with some prospect of success in this country.

During the period which has elapsed since the appearance of the first edition, change has taken place in the attitude of mind of the author. Before the appearance of the third edition, the author states that he had come under the influence of Ostwald's "*Naturphilosophie*," and as a result he sets before himself the aim "to distinguish sharply between hypothesis and fact, avoiding the former as far as is possible."

Now, it cannot be denied that among students of science too little attention is usually paid to the philosophical side of the subject, so that the true meaning of a law, an hypothesis, and a theory is insufficiently appreciated, leading as a result to the confusion of hypotheses and theory with fact. Still, it cannot be said that the cure for this is to discard hypotheses altogether. Hypotheses are most valuable for the development of a science, so long as they are recognised as such, and are kept in their place. But the author himself is apparently none too sure of his ground here. It is, of course, perfectly competent for him, if he thinks it good, to eliminate hypotheses and theories, and to confine himself to what is experimentally determinable, and to generalisations of such observed facts, but when he states (p. 187): "By the word theory, then, we do not mean a hypothesis in which something not observed is added to the facts to 'explain' them, but only a generalisation of ob-

served facts," surely he is taking undue liberties with language which can be productive only of confusion. Such a standpoint is to be regretted, for it greatly reduces the value of a book which has otherwise very much to recommend it.

(2) The second of the two books mentioned above can be heartily welcomed. It is put forward by the author as "an elementary introduction to physical chemistry," and as such the reviewer believes that it will, on the whole, be found very satisfactory. It cannot, and does not pretend to, treat in detail the whole subject of physical chemistry, but it does attempt, and this successfully, to introduce the student to the more important parts of the subject, special stress being laid on the modern theory of solutions, the principles of chemical equilibrium, electrical conductivity, and electromotive force.

The order in which the author treats his subject is as follows:—Fundamental principles of chemistry; the atomic theory; gases; liquid solutions; dilute solutions; thermochemistry; equilibrium in homogeneous systems; law of mass action; heterogeneous equilibrium; the phase rule; velocity of reaction; catalysis; electrical conductivity; equilibrium in electrolytes; strength of acids and bases; hydrolysis; theories of solution; electromotive force.

In the above treatment the author intentionally devotes comparatively little space to the discussion of physical properties and their relation to chemical constitution. In this, doubtless, he was wise; and yet one cannot help feeling that the addition of twenty, or even of ten, pages devoted to experimental results would not have greatly added to the bulk of the volume, and would certainly have been of great value in giving the student some idea of the utility of physical methods for the elucidation of chemical constitution.

In connection with the subject of dilute solutions, the treatment is not altogether satisfactory, insufficient emphasis being laid on the probability that solutions are essentially different from gases. Some indication might have been given that there is not only an experimental, but also a theoretical reason for substituting the mass of the solvent for the volume of the solution in the general osmotic equation; also the unsatisfactory character of the kinetic explanation of the mechanism of osmotic pressure should have been pointed out. Further, rather more definite guidance might have been given to the student than merely to say, "other views are that it (*i.e.* osmotic pressure) is connected with attraction between solvent and solute, or perhaps with surface tension effects," especially as the reviewer has pointed out that the surface-tension theory is untenable. It is true that the author inserts, as a saving clause, the sentence "It may be pointed out that the equivalence of osmotic pressure and gas pressure in great dilution is no evidence that they arise from the same cause," but the student will still probably continue to believe that the kinetic explanation is the best one.

The discussion of electrical conductivity and of electromotive force, two very important subjects, is very well done.

The book is wonderfully free from misprints, at least of a serious character, and on the whole the book is one which can be highly recommended to all students who wish to obtain a first acquaintance with the subject of physical chemistry. In language it is clear and well-expressed, and the practical illustrations which are appended to most of the chapters will be found very useful for laboratory work. The cost of the book, also, is extraordinarily low. A grave omission on the part of the publishers is the date of publication on the title-page.

A. F.

## ELECTRICAL ENGINEERING.

- (1) *Transformers, for Single and Multiphase Currents. A Treatise on their Theory, Construction, and Use.* By Prof. Gisbert Kapp. Second, revised and enlarged edition. Pp. ix+363. (London: Whittaker and Co., 1908.) Price 10s. 6d. net.
- (2) *Electrical Engineer's Pocket Book. A Handbook of Useful Data for Electricians and Electrical Engineers.* By Horatio A. Foster, with the Collaboration of Eminent Specialists. Fifth edition, completely revised and enlarged. Pp. xxxvi+1599. (London: A. Constable and Co., Ltd., 1908.) Price 21s. net.

(1) A NEW edition of Prof. Kapp's well-known book on transformers is bound to be interesting to all electrical engineers. Moreover, when the new edition is so much enlarged as to become practically a new book, the publication is of still greater importance.

The first two chapters are introductory in character, and deal respectively with general principles and with the losses in transformers. We cannot but feel some regret that the constants for hysteresis loss are not given in the form  $K \times B^{1.5}$ . This form gives practically the same result as the  $B^{1.6}$  formula if a suitable value of  $K$  is chosen (as Prof. Kapp states on p. 17), and the calculation of the loss if the index is 1.5 can be much more readily made. The second chapter includes some valuable results of tests on the newer alloyed irons.

One of the best of the new chapters is chapter iii., where the subject of heating of transformers is dealt with very completely. The method of estimating temperature rise graphically for intermittent loads by combining the heating and cooling curves is very clearly given. Chapter v. is a very interesting one, dealing with the much neglected subject of the design of choking coils; the method of determining the necessary volume of the air-gap to give a certain amount of wattless current is both novel and useful.

In chapter vi. the design of the core of a transformer is considered, and a good deal of space is devoted to the discussion of the distribution of losses in a transformer. Some exception must be taken to the statement on p. 123:—

"The law of equal losses gives the maximum efficiency of a transformer which is the right size for the load. Arnold's law<sup>1</sup> gives it for a transformer which is slightly too large for the load."

<sup>1</sup> Copper loss = 0.8 hysteresis loss + eddy current loss.

Arnold's law and the law of equal loss are obtained on totally different premises, and both laws are correct for the given premises. It is true also that for a transformer designed on Arnold's law a higher efficiency can be obtained by increasing the load until the copper loss is equal to the iron loss, but this load may be more than the transformer can stand, and it is no more accurate to say that Arnold's law gives maximum efficiency for a transformer that is slightly too large for its load than it would be to say that the law of equal losses gives the maximum efficiency for a transformer that is slightly too small for its load.

In chapter vii. the design of a shell transformer is worked out in detail. One must enter a protest against the introduction of "Fill Factor." This is a literal translation of the German "Füllfaktor," but the English "Space Factor," introduced by Thompson, is now so well recognised that it seems a pity to use another term.

In chapter viii. the transformer theory is worked out in the same clear way as is done in the earlier edition. Prof. Kapp's well-known diagrams are described in detail, as well as the simplified drop diagram now so largely used. In the next chapter the calculation of magnetic leakage is considered, and some useful formulæ are given for calculating it in specific cases.

Chapter x. deals with the measurement of power; the usual methods of measuring power are described, including the three amperemeter and three voltmeter methods. Students might perhaps have been warned of the great accuracy of measurement in voltage and current which is necessary to obtain good results with these two methods. Chapter xi. deals with the testing of transformers, and includes also a description of most of the modern iron-testers, including the Epstein tester for total loss, the Grassot fluxometer, and Prof. Kapp's device for measuring magnetic quality.

The next chapter deals with a number of subjects, including safety appliances for transformers, three-wire transformers, auto-transformers, series working, and Scott's system of transformation from two-phase to three-phase working. It is similar to the corresponding one in the earlier edition, though the matter is greatly increased and brought up to date.

The last chapter gives some examples of modern single-phase and three-phase transformers, and is one of the most valuable in the book, both for the student and the designer. Not only are many plates and drawings included, but the details of the designs are worked out in many cases.

This book is likely to remain a standard treatise on the subject in English for some time.

(2) The "Electrical Engineer's Pocket Book" is similar to many other pocket books of the same class already on the market. It aims, however, at giving more complete and comprehensive information than most of these compilations, and deals with such subjects as electrochemistry, illuminating engineering, electrolytic action, firing mechanism for guns, electro-metallurgy and X-rays, while more than 250 pages